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MULTIVARIATE DATA
IN THE ESTIMATION OF CONSUMER RISK

DANE WIELOWYMIAROWE
W OKREŚLANIU RYZYKA KONSUMENTÓW

Summary: The risk of consumer behaviour, as a part of the widely understood studies on risk, is still an uncharted and undiscovered area of human activity. The main goal of this paper is to draw attention to the issue of the measurement of risk perceived by the consumers` unsuccessful purchase, as well as presenting a multidimensional analysis of data on risk research perceived by consumers in the decision making process. Some of the well-known multivariate methods are presented: analysis of variance, correspondence analysis and some graphical methods for categorical data analysis, such as mosaic, sieve, association and doubledecker plot. In the paper, the qualitative analysis aimed at risk identification and interpretation in the decisions process of consumers will be conducted. The exploration of different types of risks and the influence on consumer behaviour will be identified. The perception of risk was examined based on the examples of food, home appliances and travel services (trips, holidays).

Keywords: consumer risk choice, qualitative data analysis, purchasing decisions of consumers, perceived risk.

Streszczenie: Ryzyko związane z wyborami konsumentów, które wpisuje się w szeroko rozumiane zachowania konsumentów, jest ciągle nieodkrytym i niezbadanym tematem badawczym zarówno w literaturze polskiej, jak i zagranicznej. Celem niniejszego artykułu jest zwrócenie uwagi na kwestię pomiaru postrzeganego przez konsumenta ryzyka nieudanego zakupu, a także zaprezentowanie możliwości wykorzystania danych wielowymiarowych w badaniach nad ryzykiem postrzeganym przez konsumentów. W artykule przeprowadzona zostanie analiza danych jakościowych służących identyfikacji oraz interpretacji ryzyka w decyzjach nabywczych konsumentów. Wśród wykorzystanych metod statystyki wielowymiarowej przedstawiona zostanie m.in. analiza wariancji, analiza korespondencji, a także graficzne metody analizy danych jakościowych, tj. wykres mozaikowy, sitkowy, asocjacji oraz dwupoziomowy. Podjęta zostanie także próba określenia wpływu, jakie ma postrzegane przez konsumentów ryzyko na ich decyzje nabywcze. Badanie obejmuje trzy grupy produktów: żywność, zmechanizowany sprzęt domowy (RTV i AGD) oraz usługi turystyczne (wczasy, wycieczki).

Słowa kluczowe: ryzyko wyboru konsumenta, analiza danych jakościowych, decyzje nabywcze konsumentów, postrzegane ryzyko.

1. Introduction

Theory of risk, formulated initially for the needs of insurance activity in the second part of the 20th century, arouses interest of researchers dealing with the theory of consumer behaviour, particularly in the context of purchasing decisions taken by them [*Dynamic marketing...* 1960; *Risk Taking...* 1967]. In the subject literature the statement that risk, if only perceived, becomes the main determinant of the purchasing decisions of consumers may be encountered. Consumer risk is the probability of the negative consequences of the taken decisions and it is important at the level at which it is perceived by the consumer. Many researchers believe that getting to know the nature and range of the risk perceived by the consumer enables a better understanding of some of the aspects of consumer behaviour [Mitchell 1999]. This is especially important when it comes to understanding and predicting how and why a consumer adopts, conveys and processes information when solving their decision making problems [Maciejewski 2012]. Therefore defining the role which risk plays in consumer purchasing decisions is of great importance for science in the field of consumer behaviour and particularly in the research on the rationality of such behaviour. Knowledge of the sources and character of risk perceived by consumers is also of great importance for companies. Getting to know the sources and character of risk perceived by consumers enables companies to apply more efficient means of affecting consumers (e.g. by reducing the perceived risk) and, as a result, achieve a competitive advantage by the company [Mitchell, Haris 2005; Maciejewski 2011].

The main goal of this paper is to draw attention to the issue of the measurement of risk perceived by the consumers' unsuccessful purchase, as well as presenting a multidimensional analysis of data on risk research perceived by consumers in decision making process. The presented analysis was built on the basis of the results of the research conducted within the grant of the Polish Minister of Science and Higher Education entitled "Risk in purchasing decisions of consumer – conditions, regularities", carried out in 2008-2010. This was the first research project of this type in Poland.

2. Methodology[1]

To accomplish the aim set at the beginning of the article, the author did a search query of reference books and afterwards, designed and conducted a two-stage direct research. The first stage of the research, of a quantitative character, was conducted in May 2009 in Poland, on a quota sample of 1000 people, representative in terms of gender, age and place of residence. The personal interview research (PAPI) technique was used to conduct the research. The second stage of the research was

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[1] See more about ways of measurement of consumer risk in: [Mitchell 1999; Gatnar, Maciejewski 2014].

of an explanatory, qualitative character and it was treated as a complement and aid in the survey interpretation acquired in carrying out the quantitative research. It was conducted in September 2009 in selected cities of the Silesian Voivodeship. At this stage, the method of individual in-depth interview was used (IDI). Altogether, 30 consumers underwent the quality research.

To evaluate the reliability of the final version of the research tool for the scales measuring the influence of particular types of risk on purchasing decisions of consumers, Cronbach's Coefficient Alpha has been calculated. If coefficient alfa > 0.7 is adopted as an accepted level then all scales which have been taken into consideration achieve values over this level [Nunally, Berstein, 1994] (Table 1).

Table 1. Reliability analysis of questionnaire

Scale	Cronbach's alpha
Scale 6: Perceived risk when selecting and purchasing food	0.83
Scale 7: Perceived risk when selecting and purchasing household appliances	0.87
Scale 8: Perceived risk when selecting and purchasing travel services	0.88
Scale 10: Determinants that increase the level of risk when making purchasing decisions	0.84

Source: own calculations.

As the conducted research was not exhaustive, it was necessary to match a sample. In this case the procedure of aim – quota − sample was applied. The method is based on the hypothesis that a sample is representative for the whole population if the structure of the sample in terms of important features is the same as the structure of the researched community [Schaeffer, Kerster, Janardan 1980]. The adopted features in the research were: gender, age and place of residence. On the basis of a known structure of the studied population, in reference to these features, features of units were matched. The framework of the sample was matched to be identical with the frameworks of the researched community in Poland. The survey was conducted by a trained group of coordinators and interviewers on a sample of 1000 consumers in May 2009 in thirty cities in different regions in Poland[2].

Since consumers' purchasing decisions depending on the type of product being purchased are taken differently– perceived risk was investigated with reference to the purchasing decisions of the three basic groups of products, classified according to materiality and means of consumption criteria: food (non-durable goods), household appliances (durable goods), trips and package holidays (services) (Table 2).

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[2] The selection of the regions where the interviews were conducted resulted from the previous experience gained from a study on consumer behavior realized by the Department of Market and Consumption at the University of Economics in Katowice and by means of funds at the author's disposal.

Table 2. Characteristics of the respondents taking part in PAPI

Size of the city (number of inhabitants)				
N=1000		Up to 50,000 (n=390)	51,000 – 200,000 (n=270)	Above 200,000 (n=340)
Gender (%)				
Female	52.5	51.8	52.2	53.5
Male	47.5	48.2	47.8	46.5
Age (%)				
18-29	24.7	24.4	25.6	24.4
30-44	25.5	27.4	22.2	25.9
45-59	27.5	28.5	27.4	26.5
Over 60	22.3	19.7	24.8	23.2
Average age of respondent (years)				
Age	44.5	43.6	45.1	45.1
Education level (%)				
Basic	7.1	7.4	8.5	5.6
Vocational	16.2	17.4	20.4	11.5
Secondary	47.1	49.0	42.6	48.5
Higher	29.6	26.2	28.5	34.4
Professional activity (%)				
Employed	57.0	59.2	48.1	61.5
Unemployed	43.0	40.8	51.9	38.5
Number of persons in a household (%)				
1 person	14.7	9.7	14.4	20.6
2 persons	28.2	28.5	28.1	27.9
3 persons	26.0	24.6	28.1	25.9
4 persons	21.7	25.9	20.4	17.9
5 and more	9.4	11.0	8.9	7.7
Subjective evaluation of financial status (%)				
Unsatisfactory	14.3	13.8	14.4	14.7
Average	36.1	38.7	34.8	34.1
Satisfactory	49.6	47.4	50.7	51.2

Source: own calculations.

The distribution of respondents according to gender, age and place of residence agreed with the division of the general population in Poland. Therefore in the sample, women only slightly outnumbered men, the most numerous age group constituted people of 45-59 years, and when it comes to place of residence – the residents were

from cities with up to 50 thousand inhabitants. The average age of the respondent was 44.5 years.

Almost half of those interviewed claimed to have general education, three out of ten a higher education and nearly every fourth respondent an elementary or vocational education. Together with the increase of cities' growth, the percentage of the respondents with higher education rose. In the cities with up to 50 thousand residents, every fourth of them had a higher education and in the cities of over 200 thousand – every third. The majority of households consisted of two or three persons. Every second respondent evaluated their household financial status as satisfactory, every third as average, and every seventh as unsatisfactory. The data collected in the quantity research included information about a great amount of units. Such a large data collection constituted disordered, raw material, which needed to be systematized, so that it could be used to accomplish the aims of the research. It was first grouped and counted, then the collected data was initially described. The application of SPSS 14.0 PL software with AMOS packet allowed the quick reception of information about the subject of the research.

After grouping, counting and an initial description of the collected information, a qualitative and quantitative analyses were applied. In order to do this, selected methods of categorical data analysis were applied: analysis of variance, correspondence analysis and visualizing methods for categorical data. All calculations were conducted with the use of R software.

3. Multivariate analysis of consumer risk

In this paper we present a multivariate analysis of data on consumer risk based on survey research. The research was conducted in two parts. The aim of part one was to identify the role of risk in consumers' decisions as well as to specify different kinds of risk perceived by consumers when making decisions about a purchase. In the second part, supplementary information on risk in consumers' decisions were obtained.

As consumer purchasing decisions are made differently depending on the product purchased, risk perception and the identification of its particular types were examined in terms of the purchasing decisions of three basic groups of products, classified in terms of criterion of materiality and means of product consumption: food (non durable products), household appliances (durable goods) and trips and package holidays (experiential goods). Descriptive statistics for the questionaries were computed: mean (average number of scale from 1 to 7), standard deviation and skewness.

The respondents are mostly concerned if the food they buy turns out not to be fresh (mean=4.33), and the product itself will not be worth its price (mean=4.26). The lowest risk is achieved for the answer that consumers will put on weight after consuming the product (mean=2.71) and that they will be criticized for their choice (mean=2.93).

Table 3. Descriptive statistics for scale 6 in the questionnaire

Scale 6: Food risk (N=492)	Mean	Standard deviation	Skewness
There is a risk of alimentary intoxication (e.g. because of the large content of conservants)	3.77	1.84	0.15
I will make a poor choice (I will buy something which will not fulfil my expectations, and I will not be able to buy another product)	3.63	1.75	0.15
Product will not be to my taste	4.09	1.85	0.07
Product will not be to the taste of my family	4.04	1.86	−0.11
Product will not be fresh	4.33	1.93	−0.15
Complaints will be disregarded	3.98	2.04	−0.02
Product will not be as effective as the producer/seller assured	3.82	1.68	0.13
I will overpay	3.97	1.90	0.04
Family and friends will criticize my choice	2.93	1.85	0.65
I will lose time for other shopping	3.21	1.93	0.44
I will spend money unnecessarily	3.98	1.91	0.07
I will trigger off allergy or rash	3.15	2.08	0.54
Product will turn out not to be worth its price	4.26	1.75	−0.14
I will put on weight after consuming the product	2.71	2.02	0.84

Source: own calculations.

Table 4. Descriptive statistics for scale 7 in the questionnaire

Scale 7: Household appliance risk (N=629)	Mean	Standard deviation	Skewness
I will not buy a proper product	4.31	1.84	−0.17
Producer/seller will not like to accept a claim	4.17	1.98	−0.15
Product may be a threat to life and health	3.44	2.04	0.41
Product will be expensive to maintain	4.17	1.81	−0.11
Product will not be worth its price	4.60	1.63	−0.32
Product will be difficult to use	3.40	1.95	0.39
Product will be of poor quality	4.56	1.77	−0.31
Product will be damaged during delivery	3.06	1.87	0.58
I will overpay	4.29	1.75	−0.14
I will be criticized for my choice	2.68	1.71	0.78
Product service will take too long	3.93	1.86	−0.01
Service point will be too far	3.96	1.99	−0.05
After sales service will be too expensive	4.37	1.89	−0.24
Product will be useless	3.32	1.94	0.41
I will spend money on extra functions of the product which I will not make use of later on	3.67	1.95	0.12
Hidden defects will appear	4.46	1.87	−0.18

Source: own calculations.

For the house appliance risk scale, the highest average value of the answer on the 7 point scale was for the position that the product will turn out not be worth its price (mean=4.60), as well as for the answer that hidden defects will appear (mean=4.46). The lowest risk is perceived for the position that the consumers will be criticized for their choice (mean=2.68) and that the product will be damaged during delivery (mean=3.06).

Table 5. Descriptive statistics for scale 8 in the questionnaire

Scale 8: Trips and package holidays risk (N=589)	Mean	Standard deviation	Skewness
Travel agency will deceive me	4.69	1.85	−0.44
Bad choice of travel offer	4.13	1.97	−0.06
Different kinds of inconvenience during the stay	4.24	1.74	−0.16
Delays or cancelations	4.56	1.63	−0.41
Problems with transport	4.27	1.75	−0.15
Problems will occur when dealing with health problems or accidents	4.49	1.82	−0.29
The weather will be bad	4.30	1.96	−0.22
I will not have time to rest	3.11	1.87	0.49
Poor service	3.66	1.74	0.19
My family or accompanying persons will be disappointed	3.51	1.89	0.24
I will overpay	4.30	1.77	−0.20
The reality will be different than the offer	5.05	1.65	−0.60
I will waste my time	3.20	1.87	0.45
Neighbours will be noisy	3.47	1.90	0.41
I will get sick	3.47	2.05	0.27
Additional costs will appear	4.54	1.72	−0.26

Source: own calculations.

For the trips and package holidays risk scale, the highest risk is perceived for the position that the reality will be different than the offer (mean=5.05) and that the travel agency will deceive them (mean=4.69). The lowest value of risk for trips and package holidays is perceived for the position that consumers will not have time to rest (mean=3.11) and that they will waste their time (mean=3.20). Risk in consumers perception was analysed with the use of correlation coefficients. For the three products analysed: food (scale 6), household appliances (scale 7) and travel services (scale 8) risk types, the correlation between perceived risk perceived for these types of products and their determinants (scale 10) with the use of Kendall's tau-b were conducted. The highest correlation of food risk perceived appeared for item no 12: an allergy will appear with the item of risk determinant that the product

may be dangerous for the environment ($\tau_b = 0.312$, $p = 0.000$). For household appliances risk, the highest correlation appeared for item 5 that the product will not be worth its price and the determinant of risk with item 16 that the product price will be too high ($\tau_b = 0.232$, $p = 0.000$). For travel services risk, the highest correlation appeared for item no 11 that the customer will overpay, with its determinant item that the product`s price changes too quickly ($\tau_b = 0.251$, $p = 0.000$).

In the next step of the analysis the correspondence analysis was applied. The aim of the analysis is to reveal the structure of a complex data matrix by replacing the raw data with a more simple data matrix without losing information, as well as to examine the structure of this relationship between at least two categorical variables. From the correspondence table we can see that 985 persons reduce risk (518 female, 467 male) and 15 persons do not reduce risk (7 female, 8 male). Out of the 1000 respondents, 525 were females, 475 were males. When nalyzing the risk of a bad decision when purchasing products, out of the 1000 respondents, 492 feel perceived risk when buying food, 629 feel risk when buying home appliances and 589 feel risk when buying travel services (Figure 1).

Scale 6: Do you feel risk buying a product?
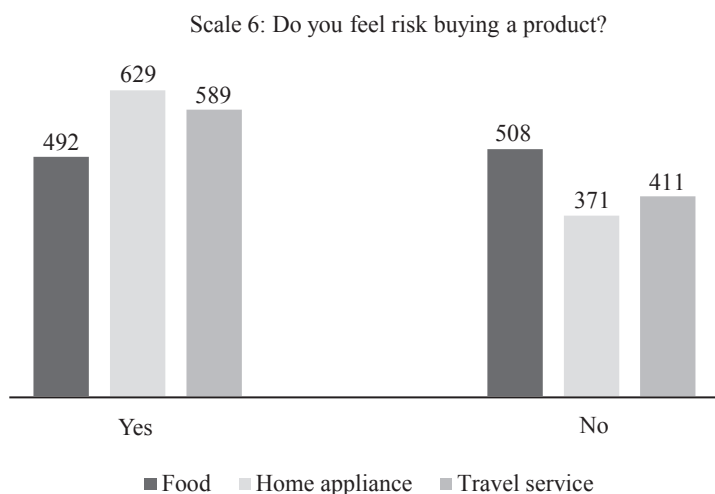
Figure 1. Do you perceive risk when buying a product – structure of answers (N=1000)

Source: own calculations.

Risk concept in the literature does not seem to prevail among Polish consumers. In the research we can see that half of the respondents (52.5%) perceive risk both as a possibility of loss and as a chance to achieve benefits, and only one out of ten perceive risk exclusively as a possibility of loss (10.2%). On the other hand, the smallest group of respondents (3.7%) perceive risk as a chance to achieve benefits. The risk structure in Polish consumers perception is presented in Figure 2.
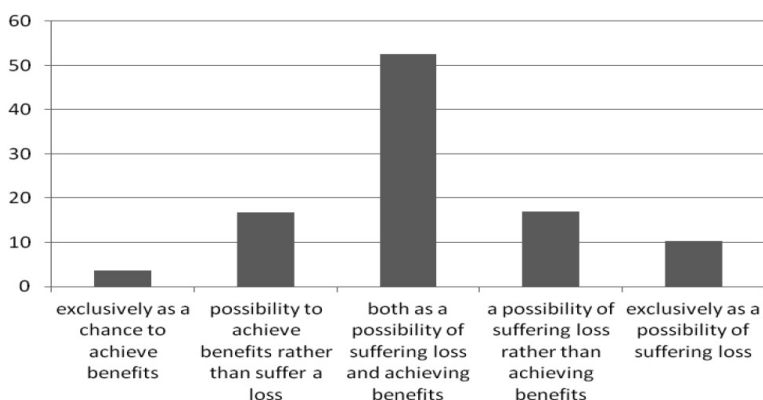
**Figure 2.** Risk in the perception of Polish consumers (N=1000)

Source: own calculations.

The conducted research showed that the risk perception is influenced by variables such as age, financial status and the consumer`s attitude to novelty. It has been noticed that together with age, the percentage of consumers who perceived risk together as the threat of suffering loss is growing. On the other hand, the better the consumers evaluate their financial status and attitude to novelty, the more they perceive risk as a chance to achieve benefits, and not as the threat of loss. With the use of multivariate visualizing methods it is also possible to present graphically the structure of a contingency table. A selected graph will be presented to analyse the table structure: mosaic plot, sieve plot, association plot and double-decker plot (Figure 3) [Friendly 2000; Brzezińska 2015].

A mosaic plot, as well as a sieve plot, presents the residual in colour, when the residual is negative, then the square is red, when positive – then blue. For customers feeling risk when purchasing household appliances and travel services, as well as not feeling risk when purchasing food, the residuals are high indicating a strong dependence between variables. An association plot presents the same residuals with the use of black and red, red indicating negative, black indicating positive residuals. The double-decker plot is similar to the mosaic plot with vertical splits for all predictors dimensions and highlighted response. We can observe that the number of respondents feeling and not feeling risk is homogenous for risk when purchasing food, household appliances and travel services.

The ANOVA method was used in order to analyze the differences between group means and their associated procedures. For three products – food, household appliances and travel services – we can observe a risk perception.

From the results of analysis of variance, we can see that there was a significant effect of a risk perception on risk when buying food, household appliances and travel services ($p = 0.000$).
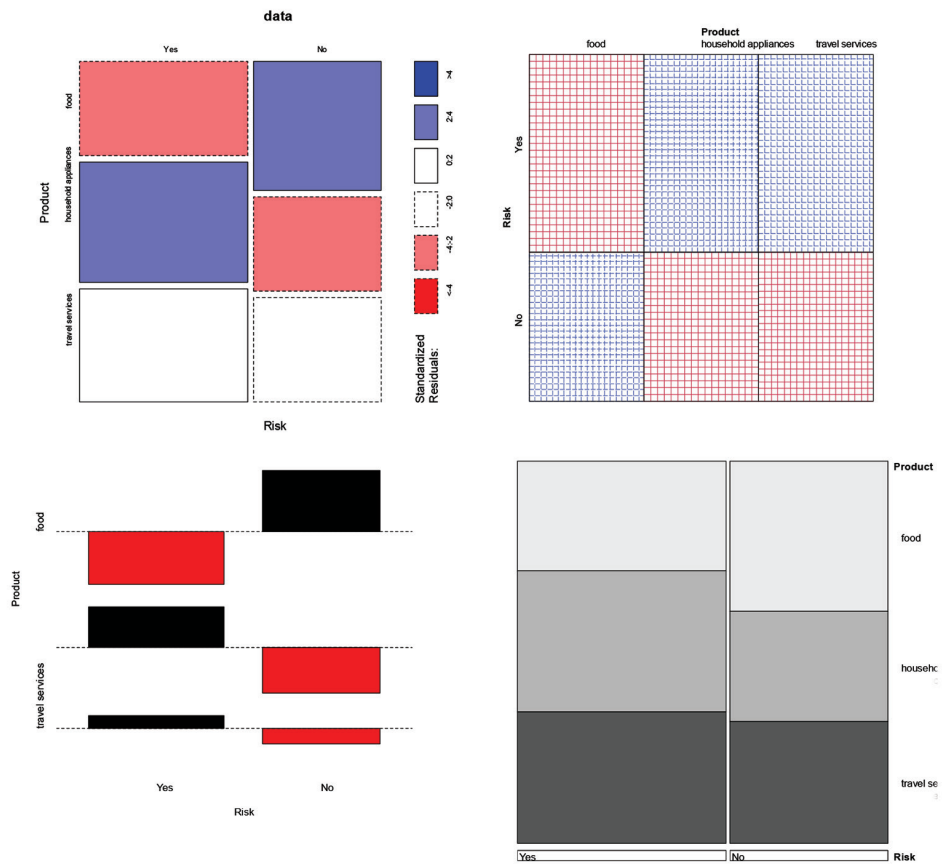
**Figure 3.** Graphical presentation of a table: mosaic plot, sieve plot, association plot and double-decker plot

Source: own calculations.

Table 6. One-way ANOVA

		Sum of Squares	df	Mean Square	F	Sig
Food risk	Between groups	138,808	2	69.404		
	Within groups	111,128	997	0.111	622.672	0
	Total	249,936	999			
Household appliance risk	Between groups	120,822	2	60.411		
	Within groups	112,537	997	0.113	535.199	0
	Total	233,359	999			
Travel services risk	Between groups	121,970	2	60.985		
	Within groups	120,109	997	0.120	506.223	0
	Total	242,079	999			

Source: own calculations.

One of the multivariate statistical methods used for categorical data in he contingency table is correspondence analysis [*Analiza danych...* 2011]. Correspondence analysis can be used to examine the relationship and correspondence structure of nominal variables. The structure of respondents' activity form and age was presented with the use of correspondence analysis. Taking into account age (18-19, 20-24, 25-29, 30-34, 35-39, 40-44, 45-49, 50-54, 55-59, 60-64 and 65+) and form of activity (casual, commission, full-time, housewife, manager, retired, student, unemployed) we can present a perception map in a two-dimensional space (Figure 4). Correspondence table that was used for the analysis is presented in Table 7.
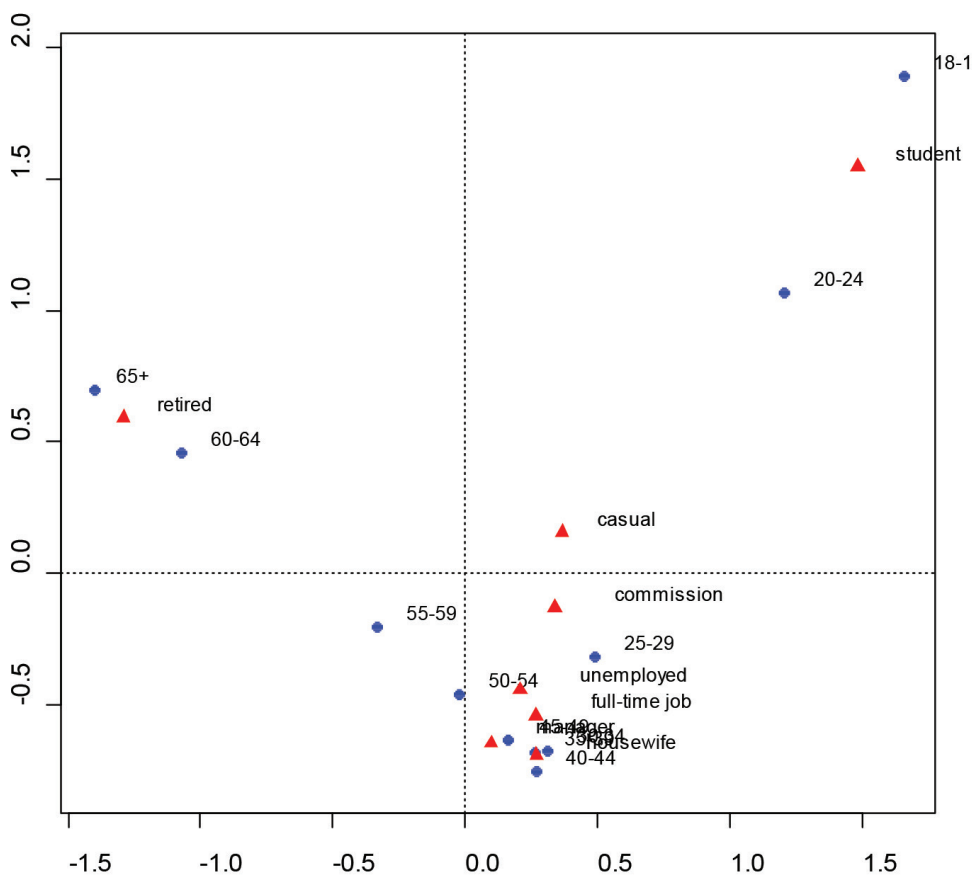
Figure 4. Perception map in two-dimensional space – respondent`s structure by age and form of activity

Source: own calculations.

Table 7. Correspondence table for correspondence analysis

Age	Activity							
	casual	commission	full-time	housewife	manager	retired	student	unemployed
18-19	0	1	2	0	0	0	37	0
20-24	4	10	23	1	1	0	63	2
25-29	3	10	56	6	10	0	13	5
30-34	0	6	58	5	21	0	2	2
35-39	1	7	46	5	15	1	0	5
40-44	0	4	49	5	21	0	0	2
45-49	2	3	52	9	15	6	0	2
50-55	2	7	43	4	23	16	0	3
55-59	0	4	36	3	10	30	0	5
60-64	1	3	6	0	3	42	0	1
65+	1	2	4	0	5	155	0	0

Source: own calculations.

We can see that one group of respondents were young consumers (18-19, 20-24 years old) who were students. The second group of respondents were consumers between 25 and 59 years old who belonged to a professionally active group (casual, commission, unemployed, full-time job, manager, housewife). The third group of respondents were consumers older than 60 who were retired. Total inertia is 1.303 indicating that there is an association between the form of activity and the respondents' age.

4. Conclusions

In this paper we presented the survey results on risk perception for Polish consumers. Some multivariate methods such as correlation analysis, correspondence analysis and advanced visualising tools were applied.

Risk behaviour was analysed on a sample size of 1000 respondents based on three products: food, home appliances and travel services. The highest risk is perceived when buying home appliance products, the smallest when buying food. Correspondence analysis was also applied for the presentation of respondents` structure in term of age and professional activity.

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